USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Utilizing Rainwater Catchments for Year-Around Agricultural Production

Focus Category: WS, AG, SW

Key Words: Water Harvesting, Impoundments, Agriculture, Benefit-Cost Analysis, Drought, Water Quality

Duration: March 1, 2000 to February 28, 2001

Fiscal Year 2000 Federal Funds: $9,000.00

Name of Principal Investigator:

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Congressional District of the University Performing Research: N/A

Statement of the Critical Territorial Water Problem:

The United States Virgin Islands import $120 million worth of food, compared to local food production valued at only $2.7 million (U.S. Department of Commerce, 1987a; U.S. Department of Commerce, 1987b). The expense of transportation and the extra time in transit leads to high food costs and lower food quality. The major constraint to agricultural production in the territory is the limited supply of suitable water (Martinez, 1999). The proposed project will address the issue of water collection and storage for agricultural use.

The climate of the U.S. Virgin Islands is tropical maritime. Annual rainfall in the islands ranges from 20 inches in the east end of St. Croix to 60 inches in the mountains of St. Thomas (Colon-Dieppa *et al.*, 1989). Average annual rainfall for the territory is about 44 inches, or 268 Mgal/d (million gallons per day). About 94% of this is lost through evapotranspiration with an additional 5.2% lost as surface or groundwater outflow to the ocean (Torres-Sierra and Rodriguez-Alonso, 1987). More problematic than the limited rainfall received by the islands is the sporadic nature of the rainfall it does receive. Wet and dry seasons are not sharply defined, but the period of December through June is relatively dry. Water shortages due to droughts can be severe because there are no perennial streams or large storage reservoirs (Colon-Dieppa *et al.*, 1989). This creates long unproductive growth periods that deter many potential agriculturalists.

Statement of Results, Benefits, and/or Information Expected to be Gained:

Using the rainwater catchment and covered storage pond described in the proposal, 84,000 gallons of sediment-free and algae-free water should be collected and stored annually. The water will be used to nourish Mr. Luka Gasperi's Senepol cattle and to irrigate his fruit trees and vegetable garden. The cost of excavating and installing this catchment/pond is expected to be recouped within three years, through a combination of reduced water expenditures and increased agricultural production. This system will be used as a model for farmers throughout the territory, whose current agricultural endeavors are restricted by the lack of freshwater resources.

Nature, Scope and Objectives of Research:

There are various ways to overcome the problem of limited, high-quality water. One is to use well water. The islands of the territory do have aquifers. Unfortunately, ground water with a total dissolved solids concentration of less than 1,000 mg/L (milligrams per liter) occurs in less than 10% of all withdraws (Zack *et al.*, 1986). Being unable to be classified as freshwater, it is generally unsuitable for irrigation. To compound this problem, yields from most wells are less than fifteen gallons per minute (Torres-Sierra and Rodriguez-Alonso, 1987). A second alternative is to buy water. Current prices are 3¢/gallon for well water (< 1,000 TDS) and 4.3¢/gallon for desalinated seawater. These costs are prohibitive for agricultural uses.

A third option to overcome the water deficit is the construction of watershed ponds. Martinez (1999) suggests this also, citing Bordeaux Estates (St. Thomas) as a possible site. This has been tried before. During the 1960s the Department of Agriculture began a program that eventually constructed over 220 ponds that were filled with surface runoff (Buros, 1976). However, there were many problems. Most soils of the territory have poor water retention qualities. With high seepage rates, most of the impounded water was quickly lost. Also, as the water flowed over land it picked up a load of sediment that was deposited in the ponds, gradually filling them until they were no longer capable of holding sufficient water. This is also the situation with Criqi Dam (St. Croix), where two-thirds of its volume has been lost to siltation (Martinez, 1999).

There are other factors affecting the suitability of impounded water for agricultural use. Apart from siltation, another problem created by the introduction of a sediment load is the portion that remains in suspension. Suspended solids clog the drip irrigation lines and micro sprinklers needed for irrigation. There is also the problem of algae growth. Standing water exposed to sunlight will quickly develop an algae bloom as farmland runoff brings excess nutrients (particularly phosphorus) into the pond. Most single single-celled organisms are harmless to an irrigation system, however filamentous algae will clog pumps, drip line emitters and micro sprinklers. The best approach for increasing agricultural water supply is using a lined pond (to prevent seepage) with a floating cover (to reduce evaporative loss) and an adjoining membrane catchment (to collect water from even the lightest rainfall). It is my objective to create one such system that will serve as a model for current and potential agriculturalists of the USVI.

Related Research:

In 1983, the University of the Virgin Islands Agricultural Experiment Station (UVI-AES) Aquaculture Program constructed a 20,000 ft^2 (100 ft wide x 200 ft long) nylon-reinforced PVC catchment (Rakocy *et al.*, 1984). The water was gravity-drained to a 3,300-gallon concrete sump where it was pumped by a 1-hp submersible pump to a series of three 20,000-gallon water storage tanks. The system collected 442,000 gallons of water annually and could store approximately 65,000 gallons. The initial construction cost of the system was recouped in less than two years considering the savings of not having to buy water from the local water and power authority. The system has been in use for more than 15 years and still provides a source of clean, high-quality water for the Aquaculture Program.

Methods, Procedures, and Facilities:

Mr. Luka Gasperi of Longford (P.O. Box 895, Christiansted USVI 00821) has volunteered to help demonstrate the feasibility of using an inexpensive rainwater catchment and covered storage pond for agricultural use. Mr. Gasperi manages Castle Nugent Farm, where he raises Senepol cattle, fruit trees and vegetables. Presently, the property has a catchment area and water storage pond, but because of the nature of the soil and topography of the land, the runoff water is loaded with suspended solids, making it unsuitable for his watering and irrigation needs. Furthermore, much of it is lost to seepage.

I propose to install a membrane catchment with an adjoining lined water impoundment with a floating cover on the same tract of land currently used (unsuccessfully) for water harvesting. The pond area (Figure 1) will have a width of 35 feet and a length of 90 feet, giving it a surface area of 3,150 ft^2. The catchment area will have a length of 55 feet and a width that starts at 35 ft and gradually tapers. It will have an area of approximately 1,347.5 ft^2 (35 ft x 55 ft x 0.7). The combined rain collecting area of both the catchment and the pond will be 4,497.5 ft^2. According to Mr. Gasperi, the mean annual rainfall on his farm is 30 inches. Assuming this to be true, the catchment/pond area will collect 84,109 gallons each year (4,497.5 ft^2 x 2.5 ft of rainfall x 7.4805 gal/ft^3). The perimeter of the catchment/pond will have a 1-ft berm to preclude the introduction of sediment-laden runoff. A 30-mil HDPE (high density polyethylene) liner (GSE Lining Technology, Inc., Houston, TX USA) will cover the entire surface area of the catchment/pond. HDPE was chosen because it has outstanding chemical resistance, environmental stress crack resistance, dimensional stability and thermal aging characteristics. It also has excellent resistance to ultra-violet radiation and has an expected life span of at least 15 years. This liner will retain rainwater, eliminate sediment, and prevent furrows from forming during heavy rains that could distort the shape of the catchment. The liner will cover the berm with the edge placed in a 1-ft deep furrow and buried (Figure 3). Outside the edge of the liner, a 4-ft tall goat-wire fence will be installed to keep cattle and other animals from walking on the liner.

The pond area will be graded by a bulldozer to have a flat bottom with a width of 15 ft and a length of 70 ft (Figure 2). A 2:1 slope (26.6°) from the outside perimeter of the pond to the perimeter of the bottom will create a 5-foot depth, which gives a total water storage volume of 78,545 gallons. Although this volume is excessive considering the total catchment/pond area, Mr. Gasperi has expressed interest in rerouting water caught from nearby rooftops into the pond area. The pond bottom will have a 3° slope allowing water to gather at one end. The pond will be covered by a 2,550-ft^2 (30 ft wide x 85 ft long) sheet of 3/16-inch thick Neoprene (American Mat & Rubber, Miami, FL USA). This size sheet will cover 50,493 gallons of water, which is 64% of maximum capacity. The sheet should reduce evaporation by 80+% while significantly eliminating algal growth (Dedrick *et al.*, 1973). The Neoprene sheet will be drilled with 0.5-inch diameter holes at 3-ft intervals to permit water to pass through. The deep end of the pond will be fitted with a 5-ft. tall stream gauge.

Mr. Gasperi will be provided with a rain gauge and a flow meter. It will be his responsibility to record daily rainfall, water depth of the pond, and water volume removed from the pond for irrigation. This will enable me to evaluate the efficiency of the liner to actually catch and store water. It will also enable me to assess the ability of the Neoprene cover to prevent evaporation. Mr. Gasperi will also bring water samples to the UVI-AES Aquaculture Program's water quality lab monthly, where they will be tested for total dissolved solids, suspended solids and pH. This will allow me to ascertain the suitability of the water for irrigation.

Technology Transfer/Information Dissemination:

One year after the catchment/pond is installed, all data collected will be compiled and analyzed. An enterprise budget will be created, showing how the catchment/pond increased farm profits *via* increased agricultural production and/or decreased water purchases. A farmer's bulletin will be written describing the installation of the system and the costs/benefits involved. A technical report will be prepared discussing methods, problems, findings and making recommendations. A series of presentations will be given explaining the results and benefits of installing a lined rainwater catchment and storage system. The presentations will be given at a WRRI seminar, the Caribbean Food Crops annual meeting, a Farmers-In-Action meeting, and the St. Croix and St. Thomas Agriculture and Food Fairs. A workshop will be held at Mr. Gasperi's farm, showing local farmers the system and promoting its merits to them. During this visit, farmers will be taught how to use rain gauges, pumping systems, and how to plan and construct drip irrigation systems. Also, they will be taught how to calculate the water needs of their particular farms and design an appropriately sized catchment/pond system. All of these events will be advertised on the audix system as well as in local newspapers, through the Dept. of Agriculture, and through the UVI Cooperative Extension Service.

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